Effects of Biogenic Isoprene Emission on Ozone Formation in the Eastern U.S.

M.L. Wesely and Yiwen Xu

Environmental Research Division
Argonne National Laboratory

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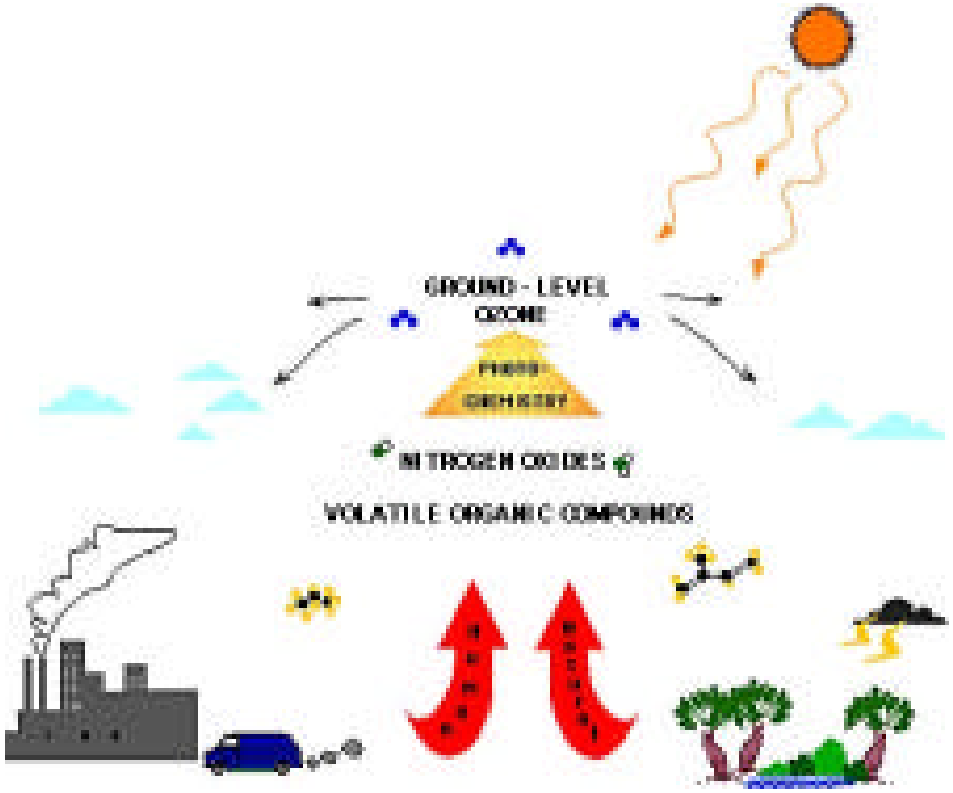
Objectives

- Develop a biogenic emission model using satellite observations
- Estimate biogenic isoprene emission over eastern U.S.
- Assess the effects of biogenic isoprene emission to regional scale ozone formation
- Indirectly evaluate the emission model results
- Provide background information for urban/local area ozone study

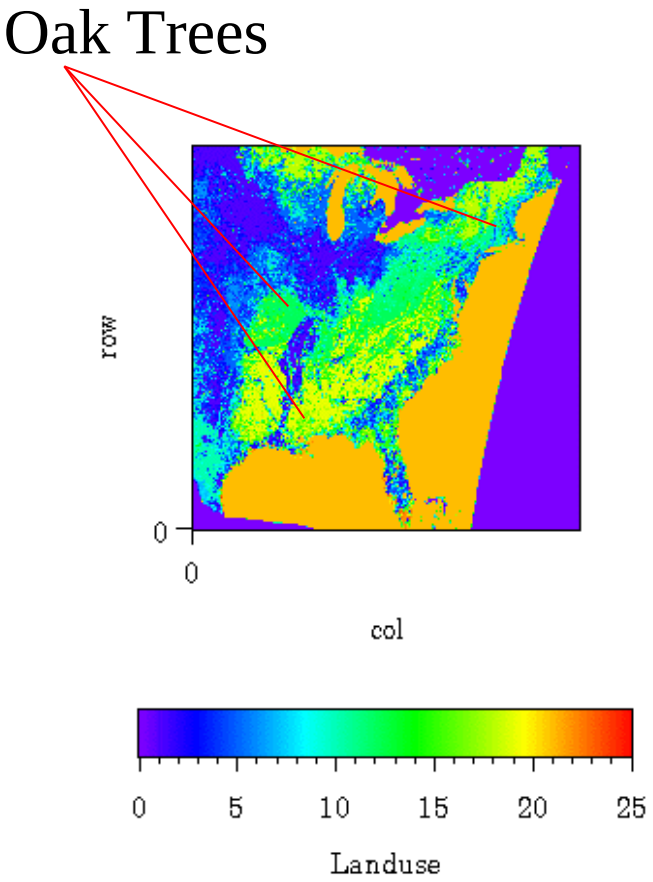
The Role of Biogenic Isoprene Emissions in Tropospheric Ozone Production

- Human activities such as fuel combustion in cars and power plants cause large increases in nitrogen oxides. These nitrogen oxides react with natural VOC /biogenic emissions and human-made VOCs, producing unnaturally high ozone concentrations.



Tree Species that Emit Isoprene in Eastern U.S.

- Isoprene is most abundant of BVOCs.
  - oak, sweetgum, eucalyptus, aspen, austl pine, and spruce are large emission sources
  - light and temperature dependent
  - removed through reactions with O_3, OH, and NO_3



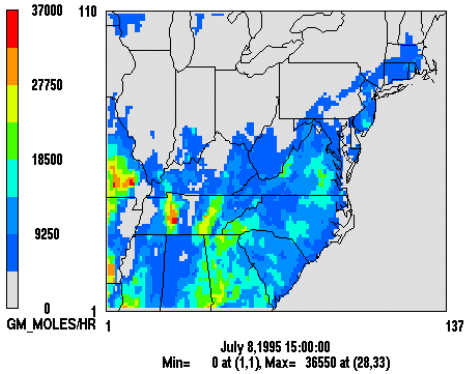
Simulations

Regional-scale O_3 concentrations were simulated for 7 and 8 July 1995, an OTAG case for high concentrations above the eastern United States. Isoprene emissions were estimated using two approaches: (1) BEIS2 standard procedures, and (2) the new biogenic emission modeling method using satellite data coupled with MM5. The meteorological model used in the OTAG study, RAMS, drove the chemistry model to simulate hourly concentrations of O_3, NO_x, isoprene, and 13 other photochemical gaseous species near the surface. Three cases were investigated (see accompanying table). The model domain was a large portion of the eastern United States with grid cells of 36 km by 36 km. A small domain, with 12-km by 12-km cell size, was nested in selected areas where high concentrations of O_3 were expected.

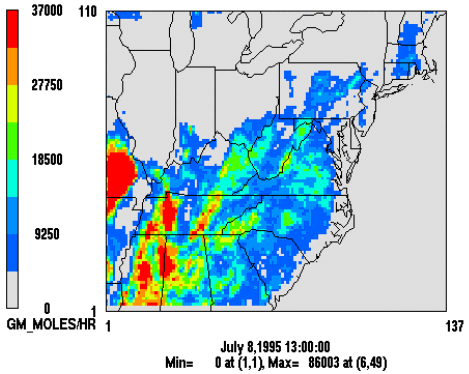
Three Simulation Cases for July 7 and 8, 1995 over Eastern United States

	CASE1	CASE2	CASE3
Isoprene emission rates	BEIS2 (OTAG data)	derived from satellite data	derived from satellite data
Meteorological fields	RAMS (OTAG data)	RAMS (OTAG data)	MM5

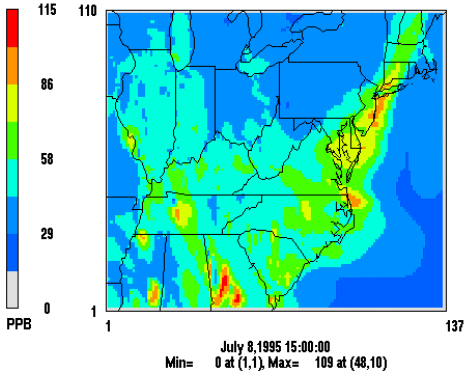
(a) isoprene emission at 15:00, 8 July



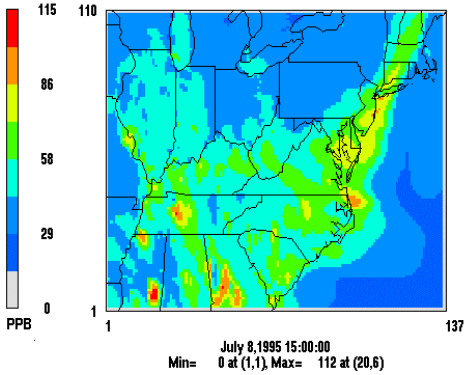
(b) isoprene emission at 15:00, 8 July



(c) ozone concentration at 15:00, 8 July

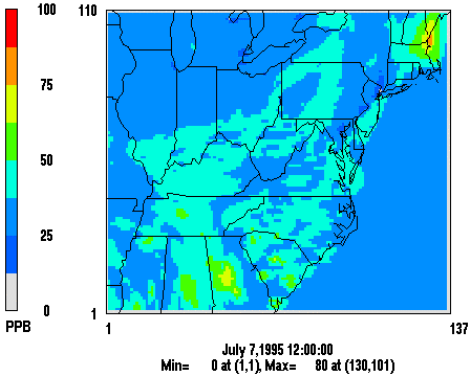


(d) ozone concentration at 15:00, 8 July

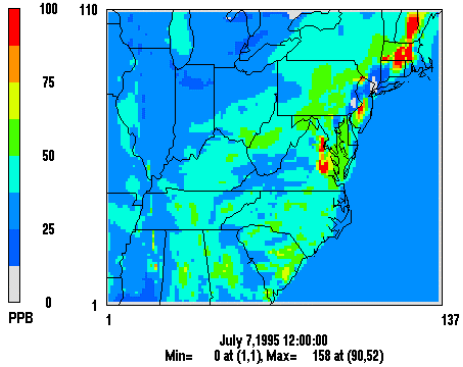


Distribution of isoprene emission rates and O_3 concentration simulated by RAMS at 12-km horizontal resolution for 1500 hours EST on 8 July 1995: (a, c) Case 1, OTAG working group emissions data set; (b, d) Case 2, emissions derived by using satellite remote sensing data.

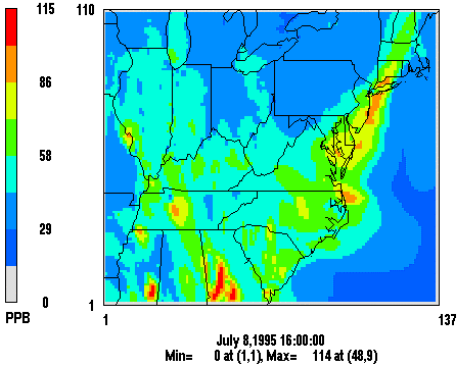
(a) ozone concentration at 12:00, 7 July



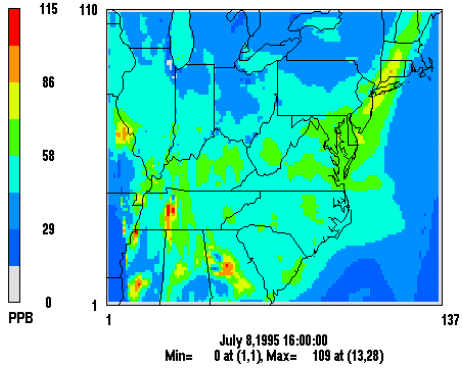
(b) ozone concentration at 12:00, 7 July



(c) ozone concentration at 16:00, 8 July



(d) ozone concentration at 16:00, 8 July



Ozone concentration maps: Case 1, with meteorological field generated by RAMS and the isoprene emissions database from the OTAG working group for (a) 1200 hours on 7 July and (c) 1600 hours on 8 July; Case 3, with meteorological fields generated by MM5 and the current model of isoprene emission rates with satellite data for (b) 1200 hours on 7 July and (d) 1600 hours on 8 July.

Sample Findings

• The results for Case 2 versus Case 1 showed that isoprene emissions affected O_3 concentration in the northeastern United States but had no noticeable impact in the southeastern United States except near large NO_x point sources.

• Cases 2 and 3 with the new biogenic emissions model produced reliable estimates of isoprene emission rates, with an improved evaluation of vegetative conditions.

• The meteorological fields simulated with MM5 versus RAMS had strong effects on the spatial patterns of O_3 concentrations.